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 TI Lead-free solder compositions, and ceramic articles soldered with
 copper-based conductors
 IN Takaoka, Hidekiyo; Hamada, Kunihiro
 PA Murata Mfg. Co., Ltd., Japan
 SO Jpn. Kokai Tokkyo Koho, 6 pp.
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AB The solder compns. contain Ni 0.01-0.5; Cu >2 and ≤5; optionally Ag 0.01-3.5, Sb 0.01-5, Zn 0.01-9, In 0.01-10, Bi 0.01-3, Ge 0.01-0.5, and/or P 0.01-0.5%, and the balance Sn. Articles soldered with Cu-based elec. conductors using the solders are claimed. The articles may be magnetic ceramics having a pair of terminal electrodes which are soldered with Cu conductor wires. The solders prevent melting of the Cu component of the conductors, so that they are suitable for soldering resin-jacketed Cu wires.

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Notes:

1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

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FULL CONTENTS

[Claim(s)]

[Claim 1] 0.5 or less weight % of nickel [0.01 weight % or more of], and the solder constituent which becomes 5 or less weight % from Remainder Sn exceeding 2 weight % of Cu(s), and is characterized by not containing Pb.

[Claim 2] The solder constituent according to claim 1 which contains at least one sort chosen from the group which furthermore consists of Ag, In, Zn, Sb, germanium, and P, and is characterized by things.

[Claim 3] At least one sort chosen from the group which consists of 0.01 to 3.5 weight % of Ag, 0.01 to 5 weight % of Sb(s), 0.01 to 9 weight % of Zn, 0.01 to 10 weight % of In(s), 0.01 to 3 weight % of Bi (s), 0.01 to 0.5 weight % of germanium, and P0.01-0.5 weight %, The solder constituent by which it is becoming [5 or less weight % / from Remainder Sn]-exceeding 2 weight % of Cu(s) characterized [0.5 or less weight % of nickel / 0.01 weight % or more of /, and].

[Claim 4] the conductor which makes Cu the main ingredients, the solder constituent given in any of Claim 1 -3 they are attached so that it might join to said conductor electrically and mechanically, ** and others -- the soldering goods characterized by things.

[Claim 5] The ceramic element assembly containing the material which functions as a magnetic substance, and the terminal electrode of the couple prepared on said ceramic element assembly, the conductor which makes a core material Cu twisted around said ceramic element assembly, a solder constituent given in any of Claim 1 -3 to which the end was attached on the other hand so that it might join to one side of said terminal electrode electrically and mechanically of said conductor they are, ** and others -- the soldering goods characterized by things.

[Detailed Description of the Invention]

[Field of the Invention] This invention relates to the solder constituent and soldering goods which do not contain Pb, and when carrying out simultaneously the covering exfoliation of a metal wire and soldering which were covered especially with insulating resin, it relates to a suitable solder constituent and soldering goods.

[Description of the Prior Art] Conventionally, in production processes, such as a coil component, since the conductor which forms a winding coil is covered with insulating resin, the covering exfoliation of a metal wire and soldering which were covered with this insulating resin are carried out simultaneously. In this case, generally using a Sn-Pb system solder constituent with the conventional high Pb content at the high temperature of 400 degrees C or more has been performed. Moreover, Sn and Cu which do not contain Pb in consideration of an environmental problem are made into the main ingredients, and the solder constituent with which the remainder consists of Ag, Bi, Sb, In, etc., and what is called a Pb free solder constituent may be used in recent years.

[Problem to be solved by the invention] However, since the conventional Sn-Pb system solder constituent contains Pb which has toxicity, the use is being restricted. [moreover, what is called a conventional Pb free solder constituent] When both covering exfoliation of the metal wire covered with above-mentioned insulating resin and soldering are simultaneously performed from Sn being the main ingredients, what is called a corrosion phenomenon that Cu component of the conductor which became unreserved dissolves in a solder constituent occurs, and there is a trouble that a conductor is disconnected. The purpose of this invention aims at offering what is called a Pb free solder constituent of Sn machine which was made that an above-mentioned trouble should be canceled and has the characteristics near the conventional Sn-Pb system solder constituent about the corrosion of the conductor which makes Cu the main ingredients.

[Means for solving problem] In order to attain the above-mentioned purpose, the solder constituent of this invention is characterized by 0.5 or less weight % of nickel [0.01 weight % or more of], and becoming 5 or less weight % from Remainder Sn exceeding 2 weight % of Cu(s), and not containing Pb. Moreover, an above-mentioned solder constituent contains at least one sort chosen from the group which consists of Ag, In, Zn, Sb, germanium, and P further, and it is characterized by things. [moreover, an above-mentioned solder constituent] At least one sort chosen from the group which consists of 0.01 to 3.5 weight % of Ag, 0.01 to 5 weight % of Sb(s), 0.01 to 9 weight % of Zn, 0.01 to 10 weight % of In(s), 0.01 to 3 weight % of Bi(s), 0.01 to 0.5 weight % of germanium, and P 0.01-0.5 weight %, It is characterized by 0.5 or less weight % of nickel [0.01 weight % or more of], and becoming 5 or less weight % from Remainder Sn exceeding 2 weight % of Cu(s). the solder constituent of this invention attached so that the soldering goods of this invention might be joined to the conductor which makes Cu the main ingredients, and a conductor electrically and mechanically, ** and others [moreover,] -- it is characterized by things. Moreover, the ceramic element assembly with which the soldering goods of this invention make a magnetic substance material the main ingredients, the terminal electrode of the couple prepared on the ceramic element assembly, the conductor which

makes a core material Cu twisted around the ceramic element assembly, the solder constituent of this invention of a conductor with which the end was attached on the other hand so that it might join to one side of a terminal electrode electrically and mechanically, ** and others -- it is characterized by things.

[Mode for carrying out the invention] It requires that the composition rate of nickel component in the solder constituent of this invention is 0.5 or less weight % in 100 weight % of solder constituents of 0.01 weight % or more. That is, if the composition rate of nickel component is less than 0.01 weight %, the effect of this invention of reducing the corrosion phenomenon of Cu conductor will not be acquired. On the other hand, when the composition rate of nickel component exceeded 0.5 weight %, and the liquidus line temperature of a solder constituent rises and it solders at the same temperature, in order for a poor bridge and a poor appearance to arise and to avoid this, when it solders at a high temperature, there is a possibility that the poor characteristics of the electronic parts by high temperature may arise. The composition rate of Cu component in the solder constituent of this invention requires that it is 5 or less weight % exceeding 2 weight % of Cu(s) among 100 weight % of solder constituents. That is, the effect of this invention of reducing the corrosion phenomenon of Cu conductor as the composition rate of Cu component is 2 or less weight % is not acquired. On the other hand, when the composition rate of Cu component exceeded 5 weight %, and the liquidus line temperature of a solder constituent rises and it solders at the same temperature, in order for a poor bridge and a poor appearance to arise and to avoid this, when it solders at a high temperature, there is a possibility that the poor characteristics of the electronic parts by high temperature may arise. The solder constituent of this invention may contain at least one sort chosen from the group which consists of Ag, In, Zn, Sb, germanium, and P further. The effect that the mechanical strength of a sex with solder or solder improves is expected by content of Ag component or Sb component, and [with content of Zn, In, and a Bi component] The effect that melting point control of solder becomes easy is expected, and the effect which controls that solder forms an oxide film by content of germanium component or P component is expected. If it is Ag among 100 weight % of solder constituents, as a concrete composition rate of an above-mentioned element 0.01 to 3.5 weight %, If it is Sb, it is 0.01 to 5 weight %, and Zn, it is 0.01 to 9 weight %, and In, it is 0.01 to 10 weight %, and Bi and it is 0.01 to 3 weight %, and germanium, if it is P, it is desirable that it is 0.01 to 0.5weight % of within the limits 0.01 to 0.5weight %. If the composition rate of Ag component is less than 0.01 weight %, the above-mentioned effect by containing Ag component, i.e., the effect that the mechanical strength of a sex with solder or solder improves, will not be acquired. On the other hand, when the composition rate of Ag component exceeds 3.5 weight %, and intermetallic compounds, such as Ag_3Sn , *****, there is a possibility of causing the fall of workability, from the problem which causes the fall of a mechanical strength, and the problem which raises liquidus line temperature. If the composition rate of Sb component is less than 0.01 weight %, the above-mentioned effect by containing Sb component, i.e., the effect that the mechanical strength of a sex with solder or solder improves, will not be acquired. On the other hand, when the composition rate of Ag component exceeds 5 weight %, and intermetallic compounds, such as SnSb , *****, there is a possibility of causing the fall of workability,

from the problem which causes the fall of a mechanical strength, and the problem which raises liquidus line temperature. If the composition rate of Zn component is less than 0.01 weight %, the above-mentioned effect by containing Zn component, i.e., the effect that melting point control of solder becomes easy, will not be acquired. On the other hand, when the composition rate of Zn component exceeds 5 weight %, and the Sn-Zn lower melting point eutectic (liquidus line temperature of 199 degrees C) of 2 yuan generates, there is a possibility of causing the fall of a solder heat-resisting property. If the composition rate of In component is less than 0.01 weight %, the above-mentioned effect by containing In component, i.e., the effect that melting point control of solder becomes easy, will not be acquired. On the other hand, when the composition rate of In component exceeds 10 weight %, and the Sn-In lower melting point eutectic (liquidus line temperature of 117 degrees C) of 2 yuan generates, there is a possibility of causing the fall of a solder heat-resisting property. If the composition rate of a Bi component is less than 0.01 weight %, the above-mentioned effect by containing a Bi component, i.e., the effect that melting point control of solder becomes easy, will not be acquired. On the other hand, when the composition rate of a Bi component exceeds 3 weight %, and the Sn-Bi lower melting point eutectic (liquidus line temperature of 139 degrees C) of 2 yuan generates, there is a possibility of causing the fall of a solder heat-resisting property. If the composition rate of germanium component is less than 0.01 weight %, the above-mentioned effect by containing germanium component, i.e., the effect which controls that solder forms an oxide film, will not be acquired. On the other hand, when the composition rate of germanium component exceeds 0.5 weight %, there is a possibility of causing the fall of workability, from the problem which raises liquidus line temperature. If the composition rate of P component is less than 0.01 weight %, the above-mentioned effect by containing P component, i.e., the effect which controls that solder forms an oxide film, will not be acquired. On the other hand, when the composition rate of P component exceeds 0.5 weight %, there is a possibility of causing the fall of workability, from the problem which raises liquidus line temperature. In addition, Na etc. is not prevented from Pb or being mixed in the solder constituent of this invention as an inevitable impurity, for example in addition to an above-mentioned component. One embodiment of the soldering goods by this invention is explained in detail based on drawing 1. the soldering goods 1 -- the ceramic element assembly 2, the terminal electrode 3 and 3, a conductor 4, the solder constituent 5 and 5, ** and others -- ** The ceramic element assembly 2 is equipped with the concave form of an element assembly equipped with the formation part near the center section of the principal plane on the other hand, including the material which functions, for example as a magnetic substance. The terminal electrode 3 and 3 are formed in the end of the length direction of the ceramic element assembly 2, for example, and the conductive paste for terminal electrode formation is applied, and it comes to bake them. A conductor 4 consists of a metal wire which made Cu the core material, for example, it is covered with insulating resin, is twisted in the direction which goes direct to the length direction of the ceramic element assembly 2, and is making the coiled form. The end 4a of a metal wire 4 and 4b are prolonged so that the terminal electrode 3 and one side of 3 may be contacted, respectively, the insulating resin which covers End 4a and 4b with the solder constituent 5 of this invention is dissolved, and the terminal electrode 3, 3

and End 4a, and 4b are joined electrically and mechanically.

Other embodiments of the soldering goods by this invention are explained in detail based on drawing 2. The soldering goods 11 consist of the ceramic element assembly 12, the terminal electrode 13 and 13, the solder constituent 14 and 14, a conductor 15 and 15, and sheath resin 16. The ceramic element assembly 12 consists of a disk type sintered compact which calcinated the ceramic green sheet. The terminal electrode 13 and 13 consist of an electrode film of the couple formed in both the principal planes of the ceramic element assembly 12. The solder constituent 14 and 14 are formed on the terminal electrode 13 and 13 so that the terminal electrode 13, 13 and a conductor 15, and 15 may be joined electrically and mechanically, respectively. Sheath resin 16 is formed so that the ceramic element assembly 12, the terminal electrode 13, 13 and the solder constituent 14, and 14 may be covered. The thing containing the material which functions, for example as dielectrics, an insulator, a semiconductor, a piezo electric crystal, and a magnetic substance can be suitably used for the ceramic element assembly 12. In addition, although the form of the ceramic element assembly 12 shown in drawing 1 is a disk type, especially the form of the ceramic element assembly 12 can use a corner guard type etc. suitably, for example, if it has the terminal electrode 13 and sufficient field to form 13, without being limited to a disk type. The terminal electrode 13 and 13 are the electrode films formed in both the principal planes of the ceramic element assembly 12. For example, when it is the thick film electrode in which film formation is carried out by the kind of reducing agent component in a plating bath as layers, such as NiP or a NiB alloy, and which uses Ag as an electric conduction component when formed of non-electrolyzed nickel plating, film formation is baked and carried out, after being printed or applied and drying Ag paste. In addition, without limiting the form and the size of a terminal electrode to the embodiment of this invention, the gap width of formation or arbitrary form can be taken and formed in both the whole principal plane of the ceramic element assembly 12, and when it is any, the effect of this invention is acquired, for example. Moreover, without being limited to the embodiment of this invention, even if the number of layers of a terminal electrode may form the terminal electrode of the 2nd layer further on the terminal electrode of the 1st layer and is formed how many layers, for example, it is not cared about. Without being limited to the embodiment of this invention, the solder constituent 14, the quality of the material of 14, form, and a size may be formation or the terminal electrode 13, and the arbitrary parts on 13, and even if they are which case, they do not care about the terminal electrode 13 and 13 of the whole, for example. [a conductor 15, the quality of the material of 15, form, and a size] The metal wire which consists of an alloy which makes Cu or Cu the main ingredients, for example is made into a core material, without being limited to the embodiment of this invention. Although the conductor of the shape of linearity which performed Sn, Cu, Pd, Au, Fe, Sn-Cu, Sn-Ag, and Sn-Ag-Cu plating on the surface of the metal wire if needed etc. can be used suitably When it is the conductor with which the surface of the metal wire was covered by insulating resin by making into a core material the metal wire which makes Cu the main ingredients, Since insulating resin is dissolved at the time of soldering and Cu core material serves as nakedness, corrosion is easy to be carried out to Sn machine solder constituent, but since this corrosion is controlled by using the solder constituent of this invention, the effect of this invention

becomes remarkable. Moreover, the number of the terminal electrode 13 and the conductors 15 joined to 13 may join two or more conductors 15 to one terminal electrode 13, without being limited to the embodiment of this invention. Although an epoxy resin, silicone resin, etc. are mentioned, if sheath resin 16 is excellent in insulation, moisture resistance, shock resistance, a heat-resisting property, etc., typical resin can be suitably used for it, for example, without being limited to especially these. In addition, it is not necessary to necessarily have sheath resin 16 and, and it may be formed how many layers. the solder constituent of this invention attached so that the soldering goods of this invention might be joined to the conductor which makes Cu the main ingredients, and a conductor electrically and mechanically, without being limited to an above-mentioned embodiment, ** and others [in addition,] -- it is turned to soldering goods at large.

[Working example] First, the solder constituent which consists of a composition rate shown in Table 1 was prepared, and it was considered as the solder constituent of the example 1-14 and the comparative example 1-7, respectively. Subsequently, the ceramic element assembly which functions as a capacitor and which makes barium titanate of 8mmphi the main ingredients was prepared, and both the whole principal plane of this ceramic element assembly was made to apply and dry Ag paste, it baked, and the terminal electrode was formed. After [subsequently,] it prepared the 99.99% ** Cu metal wire of 1mmphi as a conductor and the end of a metal wire has touched the terminal electrode of an above-mentioned ceramic element assembly Respectively it was immersed, soldered in the solder constituent of an example 1-14 and a comparative example 1-7, and the sample using the solder constituent of the example 1-14 and the comparative example 1-7 was obtained, respectively. In addition, soldering conditions were performed at 400 degrees C, 450 degrees C, and 500 degrees C, respectively, 5 sec, the submergence depth of the conductor was 10mm and immersion time carried out immersion speed in 10mm/sec. Moreover, 25 weight % of rosin IPA solution was used for flux. Then, about the sample 1-14 and the sample using the solder constituent of the comparative example 1-7, the sex with solder at the time of soldering at the corrosion speed of Cu of the conductor at the time of soldering at 400 degrees C, 450 degrees C, and 500 degrees C and 400 degrees C was measured, and evaluation was added. In addition, about the corrosion speed of Cu, after carrying out figuring of the section of the conductor after soldering with emery paper and carrying out mirror polishing with a buff, the diameter of the conductor was measured with the metallurgical microscope and it asked by the following formula. Corrosion speed (micrometer/sec) = $(1000 - \text{diameter of conductor which remains (micrometer)})/2/5$ of Cu. Moreover, about the sex with solder, the ratio of area which was asked for soldering arrival area by Image Processing Division and to which the solder to immersion area has adhered the side piece of the conductor after soldering was computed. Moreover, about what is inferior in the corrosion speed or the sex with solder of Cu among the samples of "O" and a comparative example about the sample of the range of this invention which is excellent in "O" and the next about the sample which is excellent among the ranges of this invention about especially evaluation, it was considered as "x."

[Table 1]

試料	はんだ合金組成 (質量%)											Cu溶食速度 (μm/sec)			はんだ付き性 (%)	評価
	Sn	Cu	Ni	Ag	In	Bi	Zn	Sb	Ge	P	Pb	400℃	450	500		
実施例	1	97.99	2.50	0.01								0.8	2.2	5.7	100	○
	2	97.85	2.50	0.15								0.7	2.1	5.6	100	○
	3	97.85	2.50	0.30								0.0	1.4	3.9	100	○
	4	97.50	2.50	0.50								0.2	0.1	3.5	100	○
	5	94.99	5.00	0.01								0.0	0.9	3.0	95	○
	6	94.85	5.00	0.15								0.0	0.7	1.8	95	○
	7	94.50	5.00	0.50								0.0	0.0	0.5	92	◎
	8	94.20	2.50	0.30	3.50							0.0	1.3	3.9	100	○
	9	97.70	2.50	0.30		10.00						0.0	1.1	3.8	100	○
	10	94.70	2.50	0.30			3.00					0.0	0.9	3.4	100	○
	11	88.70	2.50	0.30				9.00				0.0	0.6	1.4	90	◎
	12	92.70	2.50	0.30					5.00			0.0	1.0	3.7	100	○
	13	87.20	2.50	0.30						0.50		0.0	1.4	3.8	100	○
	14	87.20	2.50	0.30							0.50	0.0	1.4	3.9	100	○
比較例	1	97.50	2.50									1.0	2.5	6.0	100	×
	2	99.30	0.70									1.5	3.2	6.5	100	×
	3	93.00	7.00									0.0	0.8	3.0	69	×
	4	95.75	0.75		3.50							1.4	3.1	6.3	100	×
	5	96.50			3.50							1.8	4.2	8.3	100	×
	6	95.50	0.50		2.00		2.00					1.6	3.4	6.8	100	×
	7	30.00									70.00	0.0	1.1	2.2	100	-

The sample using the solder constituent of the example 7 which consists of 0.5 weight % of 5 weight % of - with an Sn of 94.5 weight % Cu(s)-nickel so that clearly from Table 1, [the sample using the solder constituent of the example 6 which consists of 0.15 weight % of 5 weight % of - with an Sn of 94.85 weight % Cu(s)-nickel] It is within the limits which a sex with solder can permit enough at 92 to 95%, and the corrosion speed of Cu at the time of soldering at 500 degrees C is 1.87micrometers/ [sec and] and 0.57micrometer/sec, respectively. As compared with the sample using the solder constituent of the comparative example 7 which consists of 70 weight % of - with an Sn of 30 weight % mentioned as comparative example Pb(s), the excellent result was obtained about the corrosion speed of Cu. Except for the sample using the solder constituent of examples 6 and 7, moreover, 0.5 or less weight % of 0.01-weight % or more nickel, [the sample using the solder constituent of the example 1-5 which becomes 5 or less weight % from Remainder Sn exceeding 2 weight % of Cu(s), and does not contain Pb] It turns out that the effect which contains nickel as compared with the solder constituent of a comparative example 1 with which the corrosion speed of Cu consists of 2.5 weight % of - with an Sn of 97.5 weight % Cu(s), i.e., the effect of this invention of reducing the corrosion phenomenon of Cu conductor, is acquired. Exceeding 0.5 or less weight % of nickel [0.01 weight % or more of], and 2 weight % of Cu(s), moreover, 5 or less weight %, The element furthermore chosen from Ag, In, Bi, Zn, Sb, germanium, and P, The corrosion speed of Cu at the time of soldering at 500 degrees C the sample using the solder constituent of the example 8-14 which consists of the remainder Sn and does not contain Pb [micrometers / // 1.4-3.9 / sec] A sex with

solder is also 90 to 100%, and it turns out that the effect, i.e., the effect of this invention of reducing the corrosion phenomenon of Cu conductor, that all contain nickel as compared with the solder constituent of a comparative example 1 is acquired. In addition, the result in which the sample using the solder constituent of the example 11 excels the sample using the solder constituent of the comparative example 7 which consists of 70 weight % of - with an Sn of 30 weight % mentioned as conventional parallel Pb(s) about the corrosion speed of Cu was obtained. On the other hand, it turns out that the sample using the solder constituent of the comparative example 2 which consists of 0.7 weight % of - with an Sn of 99.3 weight % in which content of Cu component does not contain nickel few again Cu(s) also exceeds the corrosion speed of Cu at the time of soldering at 500 degrees C in 6.0micrometers/sec, and is highly inferior. Moreover, it turns out that the sample using the solder constituent of the comparative example 3 which consists of 7 weight % of - with an Sn of 93 weight % in which content of Cu component does not contain many nickel Cu(s) is low inferior in a sex with solder at 69%. Moreover, it turns out that the corrosion speed of Cu at the time of soldering the sample using the solder constituent of the comparative example 4 which consists of 3.5 weight % of 0.75 weight % of - with an Sn of 95.75 weight % which does not contain nickel component but contains Ag component Cu(s)-Ag at 500 degrees C is highly [micrometers //sec / 6.3] inferior. Moreover, it turns out that the corrosion speed of Cu at the time of soldering the sample using the comparative example 5 solder constituent which consists of 3.5 weight % of 96.5 weight % of Sn-Ag which does not contain Cu component and nickel component, but contains Ag component at 500 degrees C is highly [micrometers //sec / 8.3] inferior. [moreover, the sample using the comparative example 6 solder constituent which consists of 2.0 weight % of - with a 0.5 weight % of - with an Sn of 95.5 weight % which does not contain nickel component but contains Ag component and Bi component Cu(s)-Ag of 2.0 weight % Bi(s)] It turns out that the corrosion speed of Cu at the time of soldering at 500 degrees C is highly [micrometers //sec / 6.8] inferior.

[Effect of the Invention] [that it is characterized by 0.5 or less weight % of nickel, and becoming 5 or less weight % from Remainder Sn exceeding 2 weight % of Cu(s) 0.01weight % or more, and not containing Pb as mentioned above according to this invention] What is called a Pb free solder constituent that has the characteristics near the conventional Sn-Pb system solder constituent about the corrosion of the conductor which makes Cu the main ingredients is obtained. Moreover, it is an above-mentioned solder constituent's containing at least one sort chosen from the group which consists of Ag, In, Zn, Sb, germanium, and P further, and characterized by things. To the coincidence which has the characteristics near the conventional Sn-Pb system solder constituent about the corrosion of the conductor which makes Cu the main ingredients, [with content of Ag component or Sb component] The effect that the mechanical strength of a sex with solder or solder improves is expected, the effect that melting point control of solder becomes easy by content of Zn, In, and a Bi component is expected, and the effect which controls that solder forms an oxide film by content of germanium component or P component is expected. the solder constituent of this invention attached so that the soldering goods of this invention might be joined to the conductor which makes Cu the main ingredients, and a conductor electrically and mechanically, ** and others -- [things / it is

considering it as the feature and] It is controlled that corrosion of the conductor which makes Cu the main ingredients is carried out with a solder constituent, and the effect that a possibility that a conductor may be disconnected decreases is acquired.

[Brief Description of the Drawings]

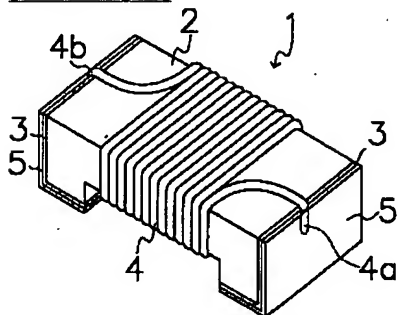
[Drawing 1] It is the perspective view of the soldering goods of one embodiment concerning this invention.

[Drawing 2] It is the fracture figure of the soldering goods of other embodiments in connection with this invention.

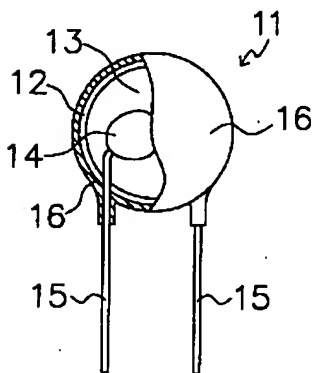
[Explanations of letters or numerals]

- 1 Soldering Goods
 - 2 Ceramic Element Assembly
 - 3 Terminal Electrode
 - 4 Conductor
 - 5 Solder Constituent
-

[Drawing 1]



[Drawing 2]



[Translation done.]